FLEISCHWIRTSCHAFT
Von der Erzeugung bis zur Vermarktung
von Lebensmitteln tierischen Ursprungs
2_2019

CONVENIENCE
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RESEARCH
Status on control of meatborne parasites

SCHWERPUNKTE
Planen, Bauen, Einrichten
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Meatborne parasites constitute an underestimated foodborne hazard. Given that records of incidents with some of these parasites date back 150 years, there are surprisingly few data on their inactivation, both as regards "conventional" as well as non-traditional (e.g., high-pressure processing) techniques. Methodological issues and a focus on pathogenic bacteria may have contributed to this absence. In view of the emerging preference for minimally processed foods, it should be reconsidered whether meatborne parasites are sufficiently addressed in food safety systems. This task was pursued by the EU COST Action "EURO-FBP: An European Network for Foodborne Parasites" (https://www.euro-fbp.org/). The present paper emerged from this action and aims at presenting the current status regarding meatborne parasites and pointing out potential deficiencies of their control in food.

Among foodborne outbreaks, foods of animal origin account for around 50% of fatalities in the EU (Da Silva Feruca et al., 2015) and the U.S. (Paxton et al., 2013). Although there are no estimates on the relative contribution of parasites compared to other hazardous agents, it is estimated that – worldwide – nearly 50% of cases of human parasitic disease are foodborne (Torsbøl et al. 2015). Among the 24 top-ranked foodborne parasites globally (FAO/WHO, 2014), eight were associated with meat: pork (Trichinella spiralis, some other Trichinella species, Toxoplasma (T.) gondii, Taenia solium, and Sarcozystis suihominis), beef (Taenia saginata, Toxoplasma gondii, and Sarcozystis bovihominis), lamb/mutton (T. gondii), game meat such as venison (some Trichinella species, T. gondii) or frog meat (Sporoforma sp.). Different priority-based rankings may emerge due to differences in the ranking model (see e.g., Torsbøl et al., 2015; Bounkwest et al., 2018), but when harmonized schemes are used – also reflect regional differences (Bounkwest et al., 2018, Tab. 1).

In EU food-safety legislation, few meatborne parasites are specifically addressed, namely tapeworm (Taenia) cysts and Trichinella muscle larvae within the framework of meat inspection (Reg. ES No. 854/2004 and Commission implementing Reg. EU No. 2015/1375). It is well established that current official controls do not address all relevant meatborne parasites, in particular Toxoplasma gondii (e.g., EFSA, 2013 and 2018). By the same token, not every clearly visible parasitic stage constitutes a public health risk (Fig.). As the primary responsibility for food safety rests with food business operators (Reg EC No. 178/2002), these should consider implementation of appropriate, HACCP-based control measures. Demographic and ethnic changes in the population will affect consumer preferences. In addition, changes in animal husbandry towards holdings with outdoor access – with associated higher biosecurity risks – in combination with minimal processing of foods create new threats to consumers’ safety.

HACCP-based food safety systems as a means to control meatborne parasites

Since parasites – unlike bacteria – will not multiply in post-mortem tissues, the control of parasitic stages throughout the meat chain should be quite straightforward. They should consist of detection of parasites and, potentially, removal of infested tissues, or, if this is

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**Keywords**

- Parasite
- Meat
- Inactivation database
- HACCP

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**Meatborne parasites**

**Tab. 1: The ranking of meatborne parasites according to their relevance can differ by regional differences in risk factors, as elaborated for Europe by Bounkwest et al. (2018).**

Tab. 1: Das Ranking von Parasiten in Fleisch nach ihrer Bedeutung kann je nach Region (aufgrund unterschiedlich ausgeprägter Risikofaktoren) verschieden ausfallen, wie von Bounkwest et al. (2018) für Europa gezeigt wurde.

<table>
<thead>
<tr>
<th>Rank</th>
<th>North-European</th>
<th>West-European</th>
<th>East-European</th>
<th>Southwest-European</th>
<th>Southeast-European</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Other Trichinella*</td>
<td>Toxoplasma gondii</td>
<td>Other Trichinella*</td>
<td>Other Trichinella*</td>
<td>Trichinella spiralis</td>
</tr>
<tr>
<td>2</td>
<td>Toxoplasma gondii</td>
<td>Trichinella spiralis</td>
<td>Trichinella spiralis</td>
<td>Toxoplasma gondii</td>
<td>Taenia saginata</td>
</tr>
<tr>
<td>3</td>
<td>Trichinella spiralis</td>
<td>Trichinella spiralis</td>
<td>Toxoplasma gondii</td>
<td>Toxoplasma gondii</td>
<td>Taenia saginata</td>
</tr>
<tr>
<td>4</td>
<td>Taenia solium</td>
<td>Taenia saginata</td>
<td>Taenia solium</td>
<td>Other Trichinella*</td>
<td>Taenia solium</td>
</tr>
</tbody>
</table>

* other than Trichinella spiralis

Source: Bounkwest et al. [2018]

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not appropriate. Implementation of treatments that ensure inactivation of the infective parasite stages. For the implementation of HACCP-based food safety assurance systems, it is essential that not only the pathogens of concern are known, but also that the nature and extents of adverse effects are described (i.e., identification and characterization of a hazard), such that the exposure of consumers can be estimated, in order to provide a risk assessment (WH0, undated). Such assessments are not generally within the responsibility of food business operators, but are conducted by expert agencies in the member states, or, at EU level, by EFSA. Relevant hazards require regulatory measures and/or adaptations of HACCP-based procedures of food businesses (risk management). In this situation, risk assessment studies allow specification of the amount of parasite reduction needed to reduce the hazard to an acceptable risk. In compliance with the 7 HACCP principles (CAC, 1997), this can be translated into critical limits (3rd principle of HACCP) for certain steps [CCPs*, HACCP principle No. 2] in the food-processing chain.

Whereas relevant meatborne parasites have been defined (e.g., FAO/WHO, 2014), quantitative risk assessments on these are scarce; these would include location in meat (no predilection site for some parasites), infective dose, parasite burden per unit of food, and the effects of food storage and processing on parasite viability. Ultimately, the data would allow establishment of Food Safety Objectives (Görs, 2005) and the definition of corresponding Performance Objectives (i.e., what level of pathogen reduction must be achieved). These could then be translated into factory- and process-specific Process Criteria (i.e., process parameters, such as heating temperature and -time) — and the latter can, in fact, serve as critical limits for CCPs.

Collating data on survival and inactivation of foodborne parasites in the food chain: the "EURO-FBP" action

In view of the obvious need for a thorough evaluation of the significance of foodborne parasites, the EU COST project FA1408, "EURO-FBP: An European Network for foodborne Parasites" (http://www.euro-fbp.org/), specifically investigated these questions, one of the major tasks being to collate and critically review information on parasite inactivation by meat-processing techniques. In conducting this evaluation, it became obvious that, for most parasites, data are too scarce to allow mathematical modelling of viability and decay, the more so, as inter-specific or intra-specific variabilities are not always known, and standardized methods for assessment of the latter do not always exist or do not allow quantification of the reduction. For bacterial pathogens, log reductions are a common way to describe the extent of inactivation. In contrast to bacteria, however, one single parasite stage in food may be enough to cause human infection for some species, which prompts for dose response data, dealing with exposure and infection, and discriminating between parasite species. Also, in the case of combined processes, the relative contribution of a single process factor would need to be known in order to construct mechanistic models for parasite inactivation. This is best illustrated by commercial meat curing and ripening processes, where NaCl content, sodium nitrite, and temperature govern the extrinsic factors pH, water activity and, thus, the survival of parasites (e.g. Trichinella: Lin et al., 1990). Since the relative contributions of the single factors and the extent of synergy are not well known, any deviation from the tested conditions would require re-evaluation.

Likewise, knowledge gaps exist for non-traditional meat processing methods, such as high-pressure processing or irradiation. The main processes have recently been reviewed (Frønsen et al., 2018), and the underlying set of data has been compiled in an excel sheet. This database will be made publicly available and the reader may refer to the EURO FBP FA1408 homepage [https://www.euro-fbp.org/] for further information.

In essence, available published data suggest that freezing at -21 °C for 1–7 days generally inactivates parasites in meat, and thus, would be a suitable preventive pre-processing control measure for most meat products. However, whether consumers are prepared to pay the extra costs that such a stage entails is less clear cut. Thermal treatment before processing must exceed 60 °C in order to inactivate parasites. As regards raw-cured shelf-stable and dried meat products, a NaCl content of 2 – 5% was effective against parasite stages in meat products. For high-pressure processing, only one report on inactivation of Toxoplasma tissue cysts in pork (300 MPa for 30 sec., Lindsay et al., 2006) was found; likewise, reports on gamma-irradiation are scarce: around 0.5 kGy was effective against Trichinella larvae and Toxoplasma tissue cysts in pork, whereas around tenfold higher irradiation doses were required for Taenia solium cysticerci (Frønsen et al., 2018). Notably, the latter treatments would not be permitted in all countries. Most work on meatborne parasites has focused on Trichinella in pork, and current animal husbandry and biosecurity practices in developed countries have substantially reduced the risk of infection of either pigs or people (Pazó, 2014).

Practical importance

In terms of meat products, Table 2 gives an outline on the potential of food processing measures in terms of parasite inactivation. Notably, few data have been published on the potential of high-hydrostatic pressure or e-beam irradiation for control of meatborne parasites. As a HACCP-based system would address also other biological hazards, in particular bacteria, it is conceivable that some control points are similar and that the critical process parameters could be adjusted to allow control of parasitic and other biological hazards as well. Admittedly, thermal processes, curing, and drying are, to some extent, addressed in national guidelines to good practice or food codex standards. Nevertheless, in the course of product development, and due to deliberate or inad-

### Tab. 2: Meat commodities and possibility for the control/inactivation of meatborne parasites (based on: IMSF, 1998 and Franssen et al., 2019)

<table>
<thead>
<tr>
<th>Treatments</th>
<th>Thermal treatment</th>
<th>Freezing</th>
<th>Salting, curing, marination, fermentation, drying</th>
<th>High hydrostatic pressure</th>
<th>Irradiation (electron beam or gamma irradiation)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Frozen meat</td>
<td>Sar, Tae, Tri, Tox</td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Raw (commingled) meat</td>
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<tr>
<td>Raw cured commingled meats</td>
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<td></td>
<td></td>
<td></td>
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<tr>
<td>Dried meats</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cooked perishable uncured meats</td>
<td>Sar, Tae, Tri, Tox</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fully retorted shelf stable uncured meats</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cooked perishable cured meats</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Shelf stable cooked cured meats</td>
<td></td>
<td></td>
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<td></td>
<td></td>
</tr>
</tbody>
</table>

Light gray = possible pre-processing treatment of raw materials; Light green = regular part of the process.

If scientific studies on the effective control of parasites in a food commodity-process-step-combination have been published, the parasite name is inserted in abbreviated form in the respective cell in the table: Sar = Sarcocystis sp., Tae = Taenias-tapeworm cysts, Tri = Trichinella larvae, Tox = Toxoplasma tissue cysts

Source: Paulsen et al.
Zusammenfassung

Aktueller Stand der Kontrolloptionen der Fleischindustrie für Parasiten in der Muskulatur


Ausschreibung

Stockmeyer Wissensschaftspreis


FEI

Friedrich-Meuser-Forschungspreis